US006480813B1

(12) **United States Patent**
Bloomquist et al.

(10) **Patent No.: US 6,480,813 B1**
(45) **Date of Patent: Nov. 12, 2002**

(54) **METHOD AND APPARATUS FOR DEFINING A PRECISION DRAWING IN A DRAWING PROGRAM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/256,661**

(22) Filed: **Feb. 24, 1999**

(51) **Int. Cl.**[7] **G06F 17/50**; G06T 11/20
(52) **U.S. Cl.** **703/1**; 345/662; 345/862
(58) **Field of Search** 703/1; 345/140, 345/133, 141–3, 113, 114, 118, 146, 157, 862, 469, 662, 856, 860, 421

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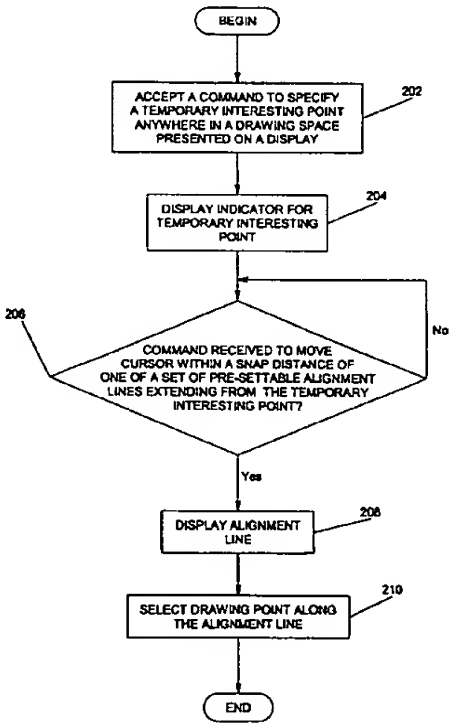
(57) **ABSTRACT**

A method, apparatus, article of manufacture for defining a precision drawing point is disclosed. The method permits the definition of temporary interesting points anywhere in the drawing space. Each temporary interesting point allows the definition of a set of candidate alignment lines, all intersecting at the temporary interesting point. When the user moves a cursor within a snap distance of one of the set of candidate alignment lines, an alignment line is displayed. The precision drawing point is then defined on the alignment line. The drawing point can be defined when the cursor is within a snap distance of one of a set of pre-settable snap distances from the temporary interesting point. Alternatively, the drawing point can be defined by selecting a second temporary interesting point associated with a second set of candidate alignment lines, and positioning the cursor within a snap distance of one of the second set of candidate alignment lines. The drawing point is then defined as the point in the drawing space where the first and second alignment lines intersect.

27 Claims, 8 Drawing Sheets



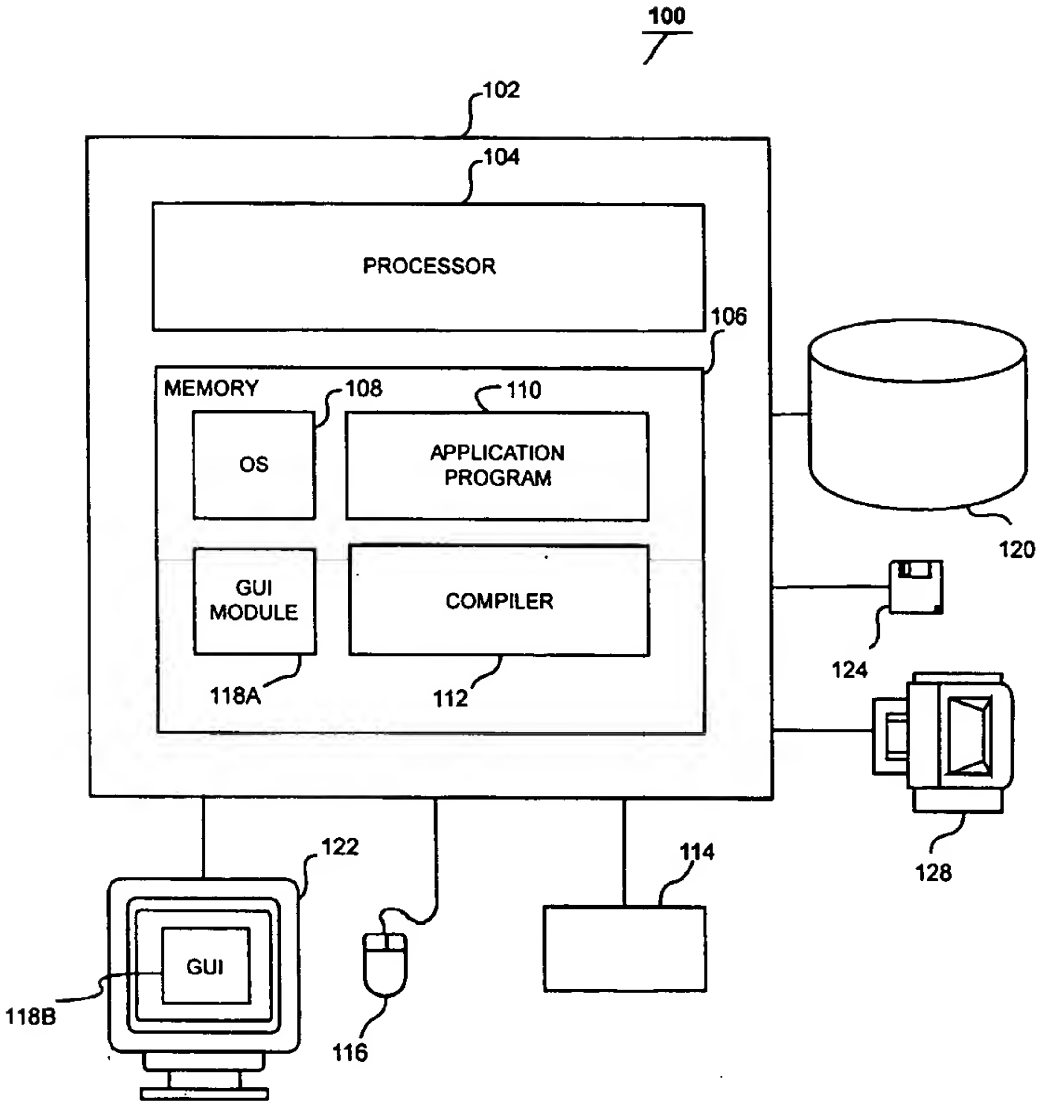

100
102
104
PROCESSOR
106
MEMORY
108
110
OS
APPLICATION PROGRAM
GUI MODULE
COMPILER
118A
112
120
124
128
122
114
GUI
118B
116

FIG. 1

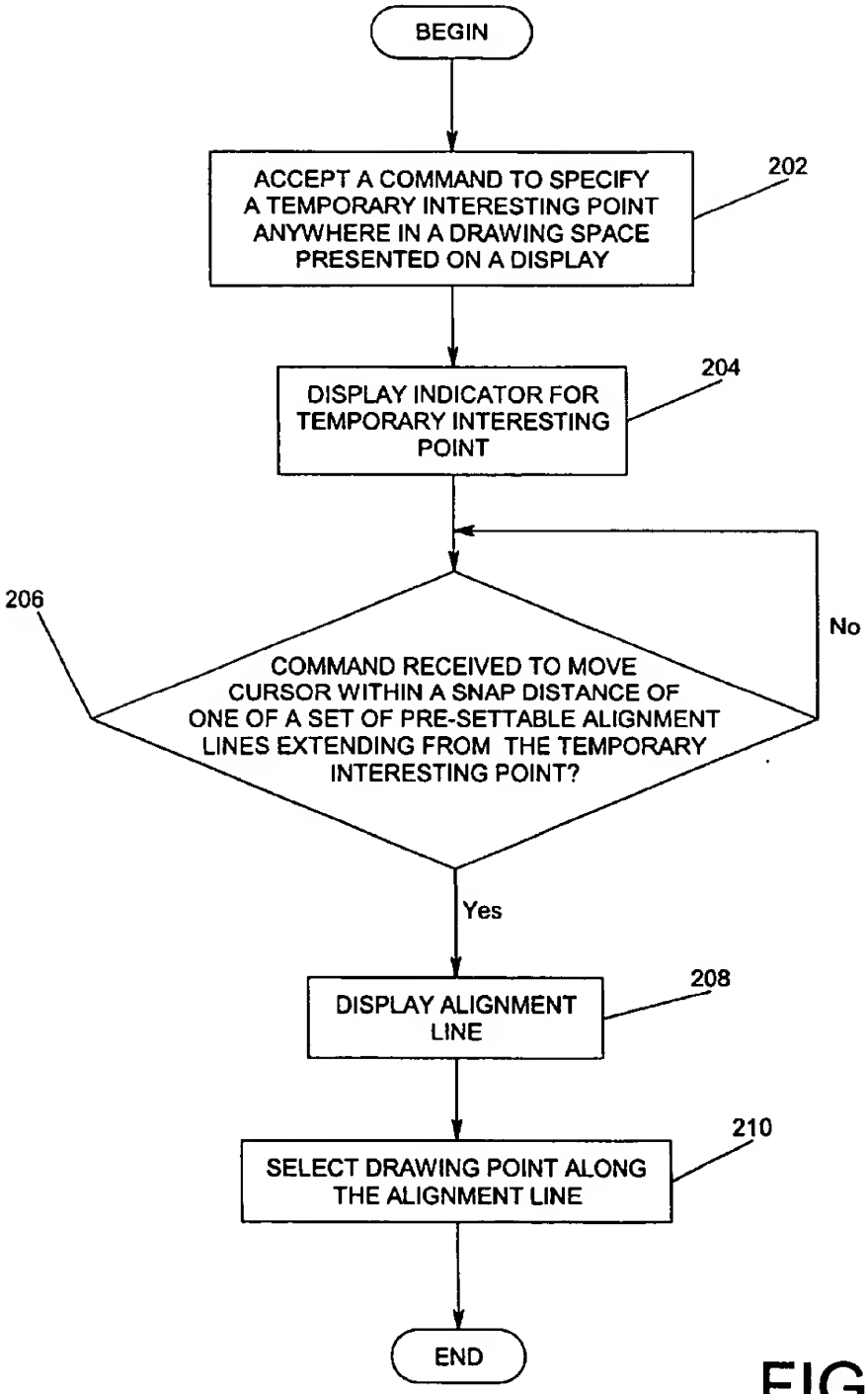

BEGIN
ACCEPT A COMMAND TO SPECIFY A TEMPORARY INTERESTING POINT ANYWHERE IN A DRAWING SPACE PRESENTED ON A DISPLAY
202
DISPLAY INDICATOR FOR TEMPORARY INTERESTING POINT
204
206
COMMAND RECEIVED TO MOVE CURSOR WITHIN A SNAP DISTANCE OF ONE OF A SET OF PRE-SETTABLE ALIGNMENT LINES EXTENDING FROM THE TEMPORARY INTERESTING POINT?
No
Yes
DISPLAY ALIGNMENT LINE
208
SELECT DRAWING POINT ALONG THE ALIGNMENT LINE
210
END

FIG. 2

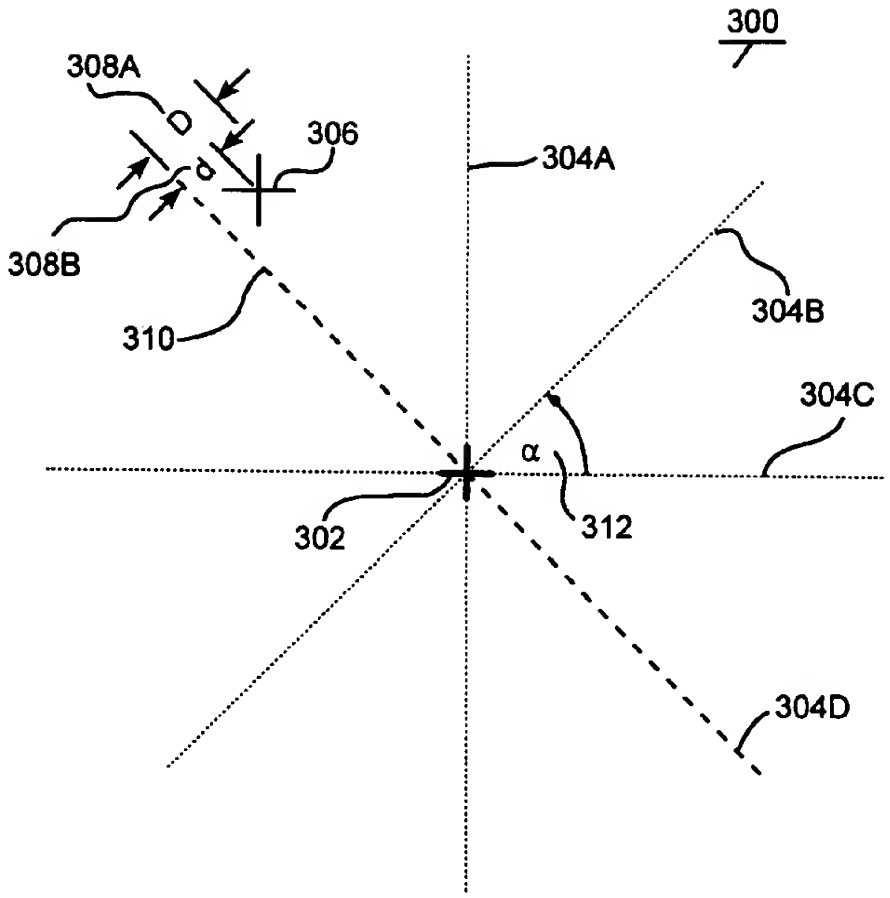


FIG. 3

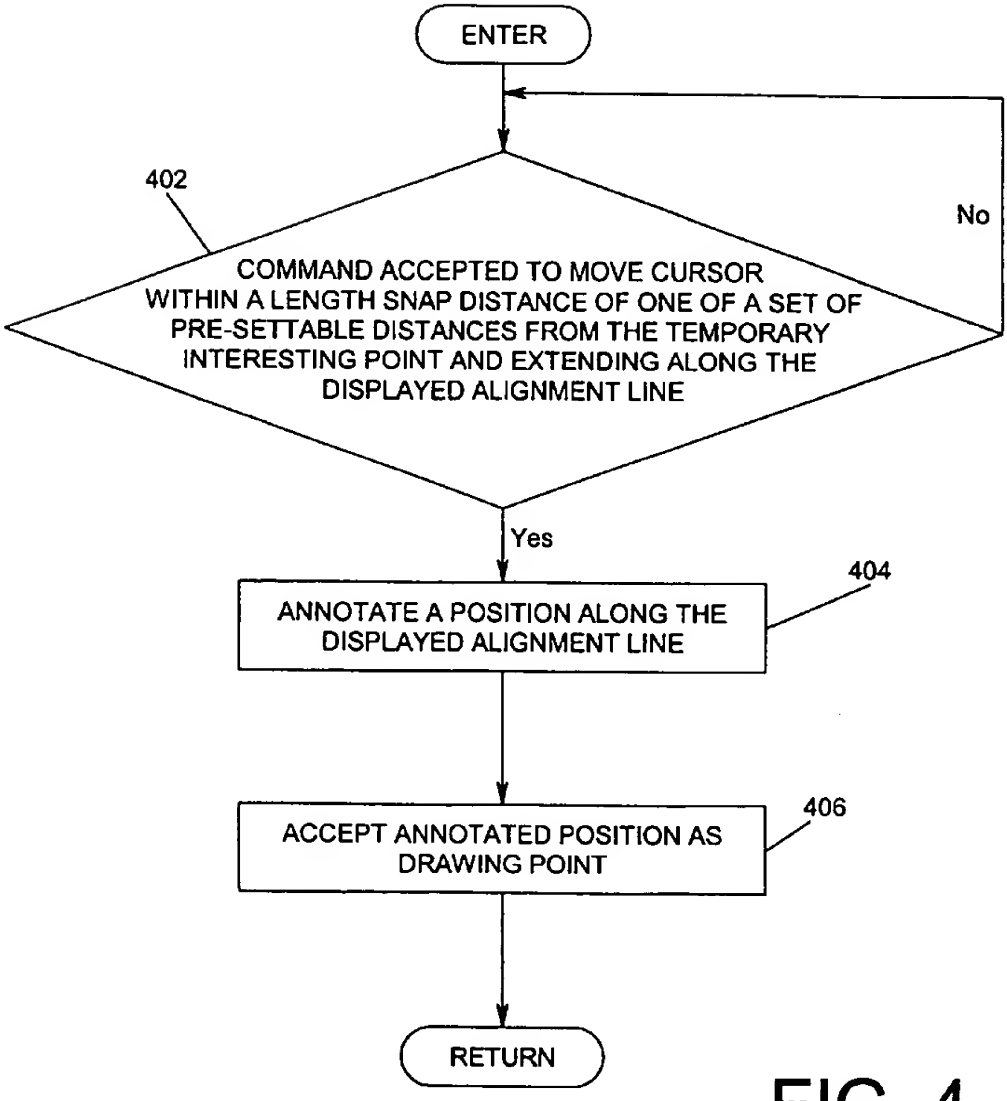

ENTER
402
COMMAND ACCEPTED TO MOVE CURSOR WITHIN A LENGTH SNAP DISTANCE OF ONE OF A SET OF PRE-SETTABLE DISTANCES FROM THE TEMPORARY INTERESTING POINT AND EXTENDING ALONG THE DISPLAYED ALIGNMENT LINE
No
Yes
404
ANNOTATE A POSITION ALONG THE DISPLAYED ALIGNMENT LINE
406
ACCEPT ANNOTATED POSITION AS DRAWING POINT
RETURN

FIG. 4

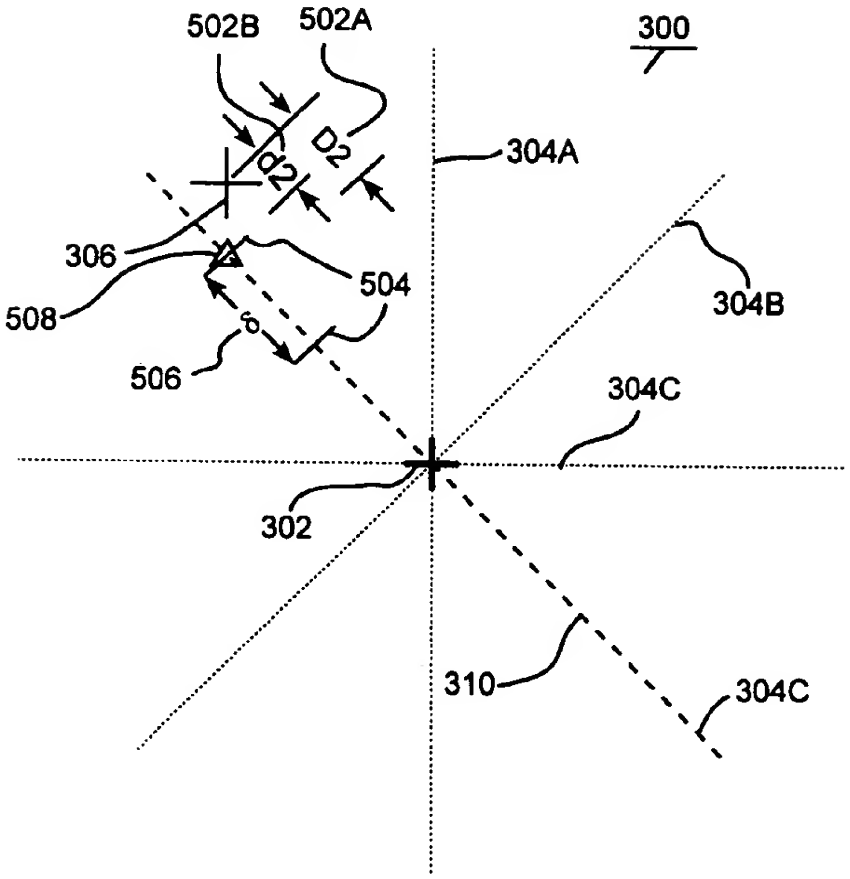

502B
502A
300
D2
d2
304A
306
504
304B
508
δ
506
304C
302
310
304C

FIG. 5

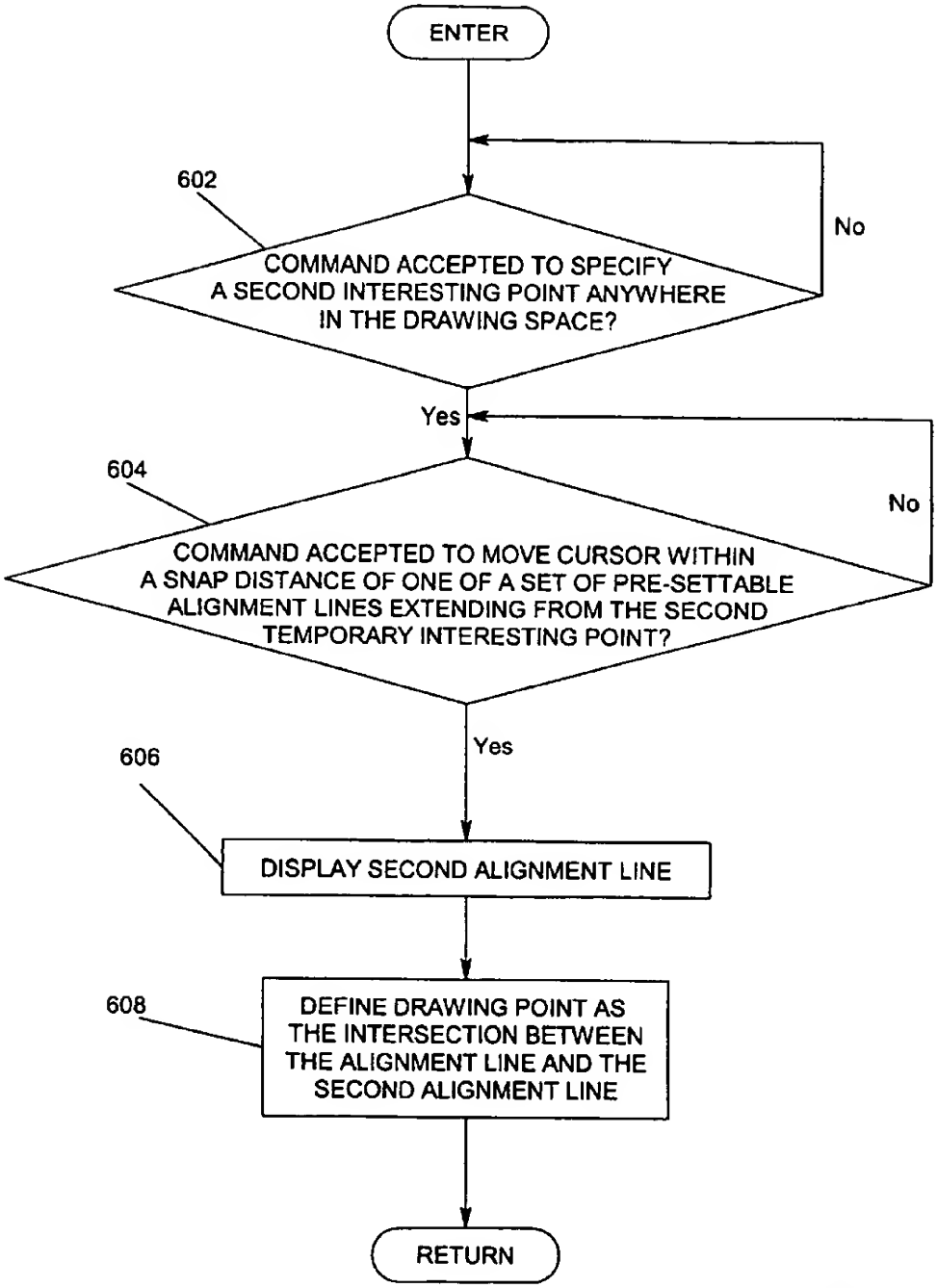

ENTER
602
COMMAND ACCEPTED TO SPECIFY A SECOND INTERESTING POINT ANYWHERE IN THE DRAWING SPACE?
No
Yes
604
COMMAND ACCEPTED TO MOVE CURSOR WITHIN A SNAP DISTANCE OF ONE OF A SET OF PRE-SETTABLE ALIGNMENT LINES EXTENDING FROM THE SECOND TEMPORARY INTERESTING POINT?
No
Yes
606
DISPLAY SECOND ALIGNMENT LINE
608
DEFINE DRAWING POINT AS THE INTERSECTION BETWEEN THE ALIGNMENT LINE AND THE SECOND ALIGNMENT LINE
RETURN

FIG. 6

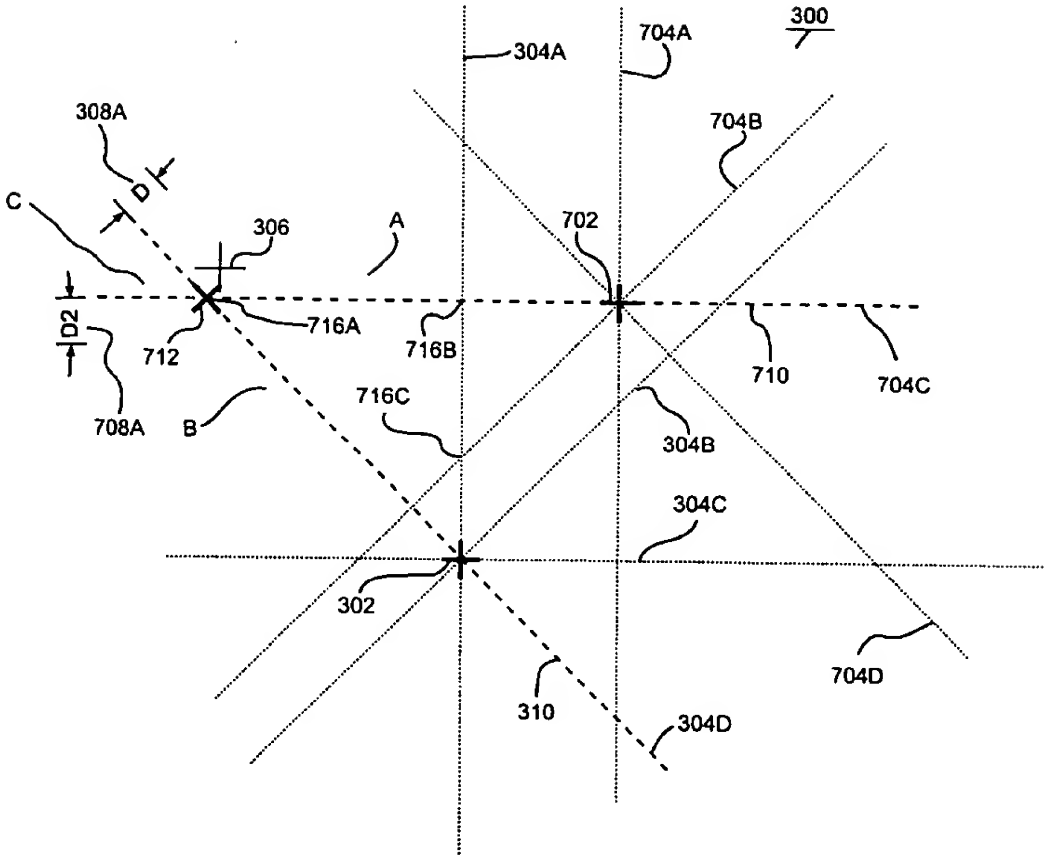

300
304A
704A
704B
308A
D1
C
306
A
702
D2
712
716A
716B
710
704C
708A
B
716C
304B
304C
302
704D
310
304D

FIG. 7

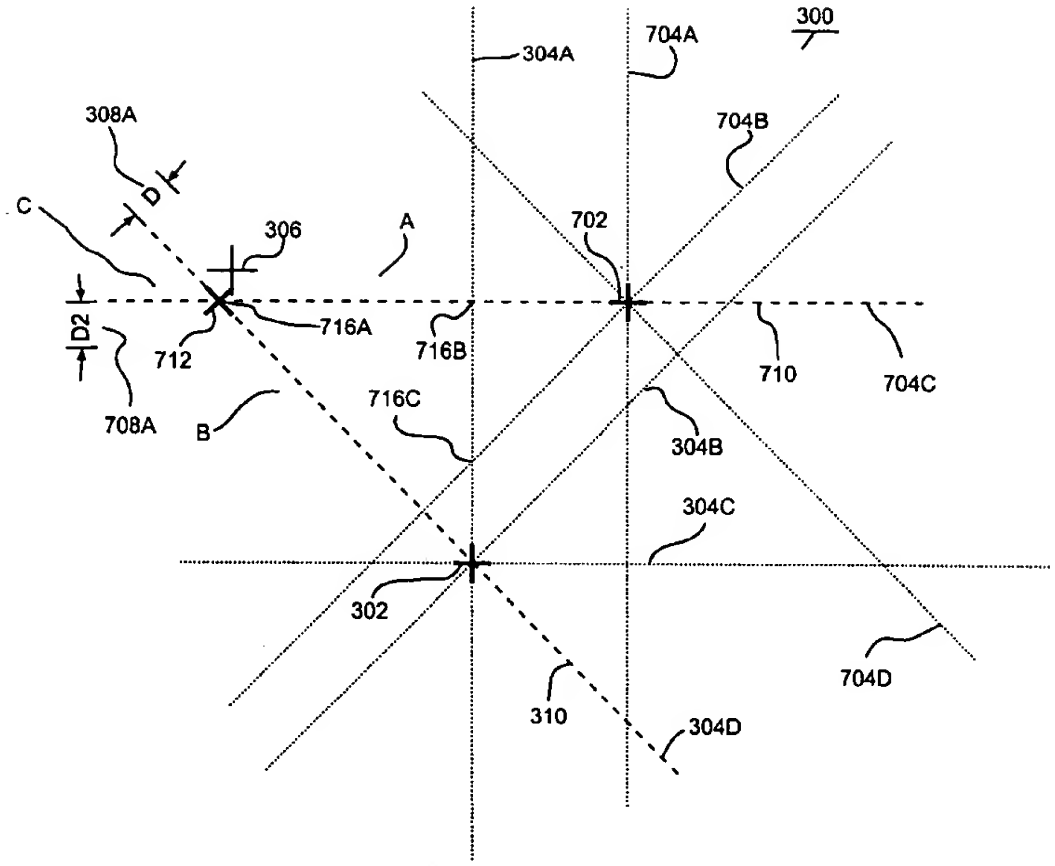

300
304A
704A
704B
308A
D1
C
306
A
702
D2
712
716A
716B
710
704C
708A
B
716C
304B
304C
302
704D
310
304D

FIG. 8

METHOD AND APPARATUS FOR DEFINING A PRECISION DRAWING IN A DRAWING PROGRAM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to the following co-pending and commonly assigned patent applications, all of which applications are incorporated by reference herein:

Application Ser. No. 09/256,896, entitled "ACQUIRING AND UNACQUIRING ALIGNMENT AND EXTENSION POINTS," filed on Feb. 24, 1999, by Alexander Thoemmes and Brett K. Bloomquist and Application Ser. No. 09/256,664, entitled "RELATIVE POLAR ANGLE SNAP TOOL," field Feb. 24, 1999, now U.S. Pat. No. 6,346,943 by Alexander Thoemmes and Brett K. Bloomquist.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to computer-implemented systems and methods for drawing images, and in particular to a computer-aided drafting tool for defining a precision drawing point based on one or more temporary points.

2. Description of the Related Art

Computer aided design (CAD) and other drawing programs allow the preparation and editing of machine drawings, schematic drawings, and artwork. Typically, the user creates these drawings with the use of a library of objects and a number of drawing tools. These drawing tools allow the user to define and edit lines, polygons, ovoids, and other shapes.

One useful feature in such drawing programs is the ability to draw new objects and to define new precision points using alignment lines based upon geometric relationships with existing objects or portions of existing objects. To accomplish this, the user first selects an interesting point on an existing object such as the end point of a line. The selection of the interesting point allows the definition of a set of magnetic alignment lines, each of which is displayed as the user moves the cursor within a snap distance of each candidate alignment line. The user can then select the precision point along the alignment line. "Magnetic alignment lines" are lines in a drawing that can be defined from one or more points identified in the drawing. These lines are used to assist the user in defining other lines and objects, but are not part of the drawing itself. Typically, the magnetic alignment lines are not displayed until a cursor approaches within a snap distance of the line. Once that occurs, the magnetic alignment line, which may optionally include a superimposed secondary cursor, appears.

Although the above-described systems allow the user to use interesting points to define alignment lines, they are limited in that they require that the user-selected interesting points be somehow associated with some existing object or geometry like the end point of a line or the center point of a circle. This can require the user to define one or more objects or shapes solely for the purpose of obtaining precision alignment lines to define a precision point. Not only is this a waste of user effort and time, but the user has to remember to delete the objects, or they will remain in the drawing. What is needed is a method for defining a precision drawing point using user-defined temporary interesting points that can be anywhere in the drawing space and unassociated with any existing objects. The present invention satisfies that need.

SUMMARY OF THE INVENTION

To address the requirements described above, the present invention discloses a method, apparatus, and article of manufacture for defining a precision drawing point in a drawing space.

The method comprises the steps of accepting a command to specify a temporary interesting point anywhere in a drawing space on a display, and displaying an alignment line when a command is accepted to move a cursor to within a snap distance of one of a set of pre-settable alignment lines extending from the temporary interesting point.

In one embodiment of the present invention, an indicator is displayed to indicate the position of the user-selected temporary interesting points. Candidate positions for the precision point can be defined and annotated as the intersection of alignment lines from two user-defined temporary interesting points, or can be defined and annotated when the cursor is moved within a length snap distance from one of a set of pre-settable distances from the temporary interesting point and extending along the displayed alignment line. The article of manufacture comprises a program storage device tangibly embodying instructions for performing the method steps described above.

The apparatus comprises means for accepting a command specifying a temporary interesting point anywhere in the drawing space, and means for displaying an alignment line when a command is accepted to move the cursor to within a snap distance of one of a set of pre-settable lines extending from the temporary interesting point.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

FIG. 1 is a block diagram showing an exemplary hardware environment for practicing the present invention;

FIG. 2 is a flow chart presenting an illustrative example of process steps used in defining a precision drawing point;

FIG. 3 is a diagram presenting an illustrative example of an application of the process steps described in FIG. 2;

FIG. 4 is a flow chart presenting an illustrative example of process steps used to select a drawing point along an alignment line;

FIG. 5 is a diagram presenting an illustrative example of an application of the process steps described in FIG. 4;

FIG. 6 is a flow chart presenting an illustrative example of process steps used to select a drawing point as the intersection of two alignment lines;

FIG. 7 is a diagram presenting an illustrative example of an application of the process steps described in FIG. 6; and

FIG. 8 is a diagram presenting an illustrative example of an alternative application of the process steps described in FIG. 6.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following description, reference is made to the accompanying drawings which form a part hereof, and which is shown, by way of illustration, several embodiments of the present invention. It is understood that other embodiments may be utilized and structural changes may be made without departing from the scope of the present invention.

Hardware Environment

FIG. 1 illustrates an exemplary computer system 100 that could be used to implement the present invention. The

computer **102** comprises a processor **104** and a memory, such as random access memory (RAM) **106**. The computer **102** is operatively coupled to a display **122**, which presents images such as windows to the user on a graphical user interface **118B**. The computer **102** may be coupled to other devices, such as a keyboard **114**, a mouse device **116**, a printer **128**, etc. Of course, those skilled in the art will recognize that any combination of the above components, or any number of different components, peripherals, and other devices, may be used with the computer **102**.

Generally, the computer **102** operates under control of an operating system **108** stored in the memory **106**, and interfaces with the user to accept inputs and commands and to present results through a graphical user interface (GUI) module **118A**. Although the GUI module **118A** is depicted as a separate module, the instructions performing the GUI functions can be resident or distributed in the operating system **108**, the application program **110**, or implemented with special purpose memory and processors. The computer **102** also implements a compiler **112** which allows an application program **110** written in a programming language such as COBOL, C++, FORTRAN, or other language to be translated into processor **104** readable code. After completion, the application **110** accesses and manipulates data stored in the memory **106** of the computer **102** using the relationships and logic that was generated using the compiler **112**.

In one embodiment, instructions implementing the operating system **108**, the computer program **110**, and the compiler **112** are tangibly embodied in a computer-readable medium, e.g., data storage device **120**, which could include one or more fixed or removable data storage devices, such as a zip drive, floppy disc drive **124**, hard drive, CD-ROM drive, tape drive, etc. Further, the operating system **108** and the computer program **110** are comprised of instructions which, when read and executed by the processor **104**, causes the computer **102** to perform the steps necessary to implement and/or use the present invention. Computer program **110** and/or operating instructions may also be tangibly embodied in memory **106** and/or data communications devices, thereby making a computer program product or article of manufacture according to the invention. As such, the terms "article of manufacture" and "computer program product" as used herein are intended to encompass a computer program accessible from any computer readable device or media.

Those skilled in the art will recognize many modifications may be made to this configuration without departing from the scope of the present invention. For example, those skilled in the art will recognize that any combination of the above components, or any number of different components, peripherals, and other devices, may be used with the present invention.

FIG. **2** is a flow chart showing the an exemplary embodiment of the operations used to define a precision drawing point. First, a command is accepted to specify a temporary interesting point in a drawing space, as shown in block **202**. The temporary interesting point is then stored and used to automatically perform precision distance and angular alignments. The temporary interesting point can be defined anywhere in the drawing space **300**, and in one embodiment, it need not be associated with any existing geometry in the drawing space.

FIG. **3** is a diagram providing an exemplary illustration of the application of the process steps described in FIG. **2**. The operation described in block **202** can be accomplished by manipulating the mouse **116** or similar input device such as a trackball or touchpad to move a cursor **306** across a drawing space **300** presented on the display **122** until the cursor **306** is positioned at the desired location, then selecting one of the mouse buttons to specify the temporary interesting point. Alternatively, keyboard **114** buttons can be used for selecting objects and moving the cursor, using arrow keys.

The specification of the temporary interesting point defines the intersection of a set of candidate alignment lines **304A–304D** (collectively referred to hereinafter as **304**). Although they are depicted in FIG. **3** for purposes of illustration, the candidate alignment lines **304** would ordinarily be invisible to the user until the cursor **306** is moved within a snap distance of one of the candidate alignment lines **304**, as described below.

In one embodiment, the angular distance α **312** between each alignment line is pre-settable. In another embodiment, when the user invokes a command to define a temporary interesting point, a dialog box is presented, asking the user to enter the angular distance between alignment lines. In the illustrated embodiment, the angular distance α **312** between each alignment line is constant. However, the present invention may be implemented by defining candidate alignment lines that are not a constant angular distance α **312** apart. In some applications, it may be desirable to define a set of candidate alignment lines in which there is a finer resolution (smaller angular distance α **312** between lines) in regions where the user is likely to demand finer resolution, and coarser resolution where finer resolution is not required. For example, the invention may be implemented where there is coarser resolution (greater angular distance between alignment lines **304**) for those lines near 90 degrees (such as alignment lines **304A** and **304C**), and finer resolution near lines of 45 degrees (such as alignment lines **304B** and **304D**). This implementation presumes that in certain regions the user is likely to want to define a precision point at a commonly used angle (such as 90 degrees), but that in other regions, the user is likely to want to define a precision point at a less-commonly used angle. The foregoing functionality can also be implemented by using different snap distances for each of the candidate alignment lines as well.

As shown in block **204** of FIG. **2**, once the temporary point has been defined, a glyph or other indicator **302** may be displayed at the location of the temporary interesting point on the drawing space **300**.

Next, block **206** determines if a command was received to move the cursor **306** within a snap distance D **308A** of one of the alignment lines **304**. When the cursor **306** is moved within a snap distance D **308A** of one of the set of candidate alignment lines **304** (to distance d **308B**, for example), an alignment line **310** is displayed in the drawing space, as shown in block **208**. The alignment line **310** provides the user with a frame of reference for selecting a precision drawing point based upon a geometric relationship with the temporary interesting point. The user can then select one or more drawing points along the alignment line **310**, as shown in block **210**.

FIG. **4** is a block diagram illustrating exemplary process steps used to select the drawing point on the alignment line **310**. In this embodiment, the drawing point is determined by snapping to one of a set of pre-settable distances from the temporary interesting point. First, as shown in block **402**, a command is accepted to move the cursor **306** within a length snap distance D2 **502A** from one of a set of distance points **504** from the temporary interesting point extending along

the displayed alignment line **310**. When this occurs, a position is annotated along the displayed alignment line, as shown in block **404**.

FIG. **5** is a diagram providing an exemplary illustration of the application of the process steps described in FIG. **4**. In the example illustrated in FIG. **5**, the distance d2 **502**B from the cursor **306** to one of the distance points **504** is less than the snap distance D2 **502**A. Hence, using a glyph or other indication **508** of the position is annotated along the displayed alignment line. Thereafter, the user can select the annotated position as the drawing point by an appropriate selection of one of the mouse **116** buttons or the keyboard **114** keys, as shown in block **404**.

The distance **506** between each of the distance points **504** can be pre-settable to a fixed value, or user-selectable via the dialog box described above. In the embodiment illustrated in FIG. **5**, the distance **506** between the distance points **504** is constant, but this need not be the case. For example, the distance **506** between distance points **504** may provide finer resolution near the temporary point, if desired.

FIG. **6** is a flow chart illustrating another embodiment of exemplary process steps used to select the drawing point on the alignment line **310**. Block **602** checks to see if a command to specify a second interesting point anywhere in the drawing space has been accepted.

FIG. **7** is a diagram providing an exemplary illustration of the application of the process steps described in FIG. **6**. Once the second temporary interesting point has been selected, a second set of candidate alignment lines **704**A–**704**D (collectively referred to hereinafter as **704**) can be defined, using the techniques described above. If desired, an indicator for the second temporary point **702** can be displayed.

Block **604** checks to determine if a command has been accepted to move the cursor **306** within a snap distance of one of the second set of candidate alignment lines. The process of making this determination is performed using the techniques described above. If the cursor has been moved within a snap distance of one of the second set of candidate alignment lines, logic is transferred to block **606**, which displays **606** a second alignment line **710**.

The first set of candidate alignment lines **304** and the second set of candidate alignment lines **704** will include lines that will intersect at particular points in the drawing space **300**. In the example shown in FIG. **7**, candidate alignment lines intersect at points **716**A, **716**B and **716**C (collectively referred to hereinafter as **716**). As the user moves the cursor **306** throughout the drawing space **300**, the cursor will be placed in regions which are not within the snap distance of any of the first set of candidate alignment lines **304** or the second set of candidate alignment lines **704**. In this situation, no alignment line is displayed. When the cursor **306** is moved to other regions of the drawing space **300**, the cursor **306** will be within the snap distance of one of the first set of candidate alignment lines **304** or the second set of candidate alignment lines **704**, but not both. In these regions (illustrated as A and B in FIG. **7**), only one alignment line is displayed. The cursor **306** may also be moved to other regions in which it is within the snap distance of one of the first set of candidate alignment lines **304** and one of the second set of candidate alignment lines **704**. In these regions (denoted as C in FIG. **7**), an alignment line **310** from the first set of candidate alignment lines **304** and an alignment line **710** from the second set of candidate alignment lines **704** is presented. At this point, a glyph or other indicator **712** can be displayed to indicated the precision drawing point, and the user can select the precision drawing point as the intersection of the first alignment line **310** and the second alignment line **710**. After selection, the glyphs **302** and **702** and alignment lines **710** and **310** can be removed from the drawing space **300**.

FIG. **8** shows an alternative embodiment of the present invention in which the snap distance to each line D **308**A and D2 **708**A can vary with the distance from the temporary points. This implementation is useful in situations where the temporary points positioned at **302** and **702** are close together (for example, at a distance less than the snap distances D **308**A and D2 **708**A), because it prevents the display of a multiplicity of alignment lines. If necessary, logic can be implemented to determine the separation of the temporary points, and the implementations described in FIG. **7** and FIG. **8** can be selected on this basis. The present invention can also be implemented by using an angular snap distance instead of a linear snap distance. In this implementation, the decision to snap to one of the candidate alignment lines **304** or **704** is made based upon the angle between the line described by the cursor and the temporary interesting point and the candidate alignment line **304**. If the angle thus formed is less than a snap angle, the alignment line **310** is displayed in the drawing space **300**. This implementation will also prevent the display of a multiplicity of alignment lines in cases where the temporary points are close together. If necessary, logic can be implemented to determine the separation of the temporary points, and a decision made as to whether the angular or linear distance snap techniques is used.

CONCLUSIONS

This concludes the description of the preferred embodiments of the present invention. In summary, the present invention describes a method, apparatus, and article of manufacture for defining a precision drawing point in a drawing space.

The method comprises the steps of accepting a command to specify a temporary interesting point anywhere in a drawing space on a display, and displaying an alignment line when a command is accepted to move a cursor to within a snap distance of one of a set of pre-settable alignment lines extending from the temporary interesting point.

In one embodiment of the present invention, an indicator is displayed to indicate the position of the user-selected temporary interesting points. Candidate positions for the precision point can be defined and annotated as the intersection of alignment lines from two user-defined temporary interesting points, or can be defined and annotated when the cursor is moved within a length snap distance from one of a set of pre-settable distances from the temporary into resting point and extending along the displayed alignment line. The article of manufacture comprises a program storage device tangibly embodying instructions for performing the method steps described above.

The apparatus comprises means for accepting a command specifying a temporary interesting point anywhere in the drawing space, and means for displaying an alignment line when a command is accepted to move the cursor to within a snap distance of one of a set of pre-settable lines extending from the temporary interesting point.

As described above, the present invention gives the user the flexibility to define temporary interesting points anywhere in a drawing space, and to use those temporary interesting points to assist in the definition of a precision drawing point. The temporary drawing points need not be

associated with any existing objects or features in the drawing space, and can be used to align or extend objects as desired.

The foregoing description of the preferred embodiment of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto. The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

What is claimed is:

1. A method of defining a precision drawing point, comprising:

specifying a user-selected temporary point anywhere in a drawing space, wherein the temporary point is unassociated with any existing geometry in the drawing space;

defining a set of alignment lines that intersect at the user-selected temporary point in response to the specifying; and

displaying an alignment line from the set of alignment lines when a cursor is moved to within a snap distance of the alignment line.

2. The method of claim 1, further comprising displaying an indicator for the temporary point.

3. The method of claim 1, wherein the snap distance is an angular snap distance.

4. The method of claim 1, wherein the snap distance is a linear snap distance.

5. The method of claim 1, further comprising selecting the drawing point along the alignment line.

6. The method of claim 5, wherein selecting the drawing point along the alignment line comprises:

annotating a position along the displayed alignment line when the cursor is moved to within a length snap distance of one of a set of pre-settable distances from the temporary point and extending along the displayed alignment line; and

accepting the annotated position as the drawing point.

7. The method of claim 6, further comprising removing the alignment line and a temporary point indicator when the annotated position is selected as the drawing point.

8. The method of claim 1, further comprising:

specifying a second temporary point anywhere in the drawing space presented on the display; and

displaying a second alignment line when the cursor is moved within a snap distance of one of a second set of alignment lines extending from the second temporary point.

9. The method of claim 8, further comprising selecting the drawing point as the intersection of the alignment line and the second alignment line.

10. An apparatus for defining a precision drawing point, comprising:

means for specifying a user-selected temporary point anywhere in a drawing space, wherein the temporary point is unassociated with any existing geometry in the driving space;

means for defining, in response to the specifying, a set of alignment lines that intersect at the user-selected temporary point; and

means for displaying an alignment line from the set of alignment lines when a cursor is moved to within a snap distance of the alignment line.

11. The apparatus of claim 10, further comprising means for displaying an indicator for the temporary point.

12. The apparatus of claim 10, wherein the snap distance is an angular snap distance.

13. The apparatus of claim 10, wherein the snap distance is a linear snap distance.

14. The apparatus of claim 10, further comprising means for selecting the drawing point along the alignment line.

15. The apparatus of claim 14, wherein the means for selecting the drawing point along the alignment line comprises:

means for annotating a position along the displayed alignment line when the cursor is moved to within a length snap distance of one of a set of pre-settable distances from the temporary point and extending along the displayed alignment line; and

means for accepting the annotated position as the drawing point.

16. The apparatus of claim 15, further comprising means for removing the alignment line and a temporary point indicator when the annotated position is selected as the drawing point.

17. The apparatus of claim 10, further comprising:

means for specifying a second temporary point anywhere in the drawing space presented on the display; and

means for displaying a second alignment line when the cursor is moved within a snap distance of one of a second set of alignment lines extending from the second temporary point.

18. The apparatus of claim 17, further comprising means for selecting the drawing point as the intersection of the alignment line and the second alignment line.

19. A program storage device, readable by a computer, tangibly embodying at least one program of instructions executable by the computer to perform a method of defining a precision drawing point, the method comprising:

specifying a user-selected temporary point anywhere in a drawing space, wherein the temporary point is unassociated with any existing geometry in the drawing space;

defining a set of alignment lines that intersect at the user-selected temporary point in response to the specifying; and

displaying an alignment line from the set of alignment lines when a cursor is moved to within a snap distance of the alignment line.

20. The program storage device of claim 19, further comprising displaying an indicator for the temporary point.

21. The program storage device of claim 19, wherein the snap distance is an angular snap distance.

22. The program storage device of claim 19, wherein the snap distance is a linear snap distance.

23. The program storage device of claim 19, wherein the method further comprises selecting the drawing point along the alignment line.

24. The program storage device of claim 23, wherein selecting the drawing point along the alignment line comprises

annotating a position along the displayed alignment line when the cursor is moved to within a length snap distance of one of a set of pre-settable distances from the temporary point and extending along the displayed alignment line; and

accepting the annotated position as the drawing point.

25. The program storage device of claim 24, wherein the method further comprises removing the alignment line and the temporary point indicator when the annotated position is selected as the drawing point.

26. The program storage device of claim 19, wherein the method further comprises:

specifying a second temporary point anywhere in the drawing space presented on the display; and

displaying a second alignment line when the cursor is moved within a snap distance of one of a second set of alignment lines extending from the second temporary point.

27. The program storage device of claim 26, wherein the method further comprises selecting the drawing point as the intersection of the alignment line and the second alignment line.

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